AD 688558

AIR FORCE OFFICE OF SCIENTIFIC RESEARCH
UNITED STATES AIR FORCE
ARLINGTON, VA. 22209

AFOSR 69-1205TR
MAY 1969

A LOOK AT TECHNOLOGIES VIS-A-VIS INFORMATION HANDLING TECHNIQUES

ROWENA W. SWANSON

Prepared for presentation at a Conference on "The Role of Micrographics in Modern Information Systems" at Texas A & M University, 5-6 June 1969.

22

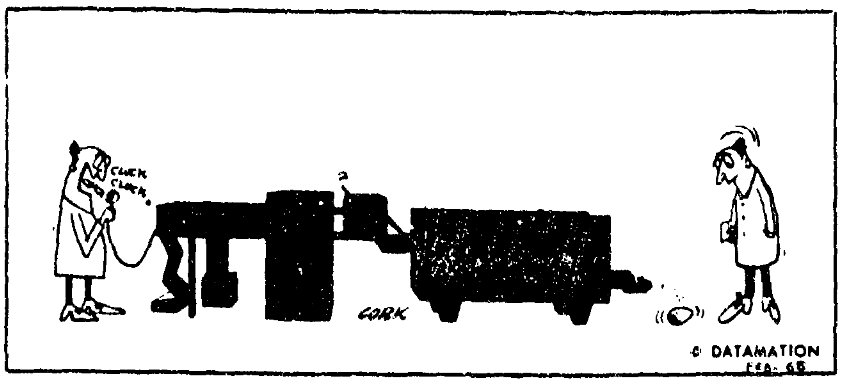
INTRODUCTION

The expression, "need to know," is, today, almost a euphemistic phrase for denoting the requirement for operating in our information-rich environments. Although luck, intuition, and hunches are likely to retain a place in many endeavors, the individual or organization having the right information at the right time in the right place has at least an initial advantage over those without this information. Thus, efforts to improve access to and control of information resources are paralleling the production of information. There is, however, a serious imbalance between these two activities. Production has been the hare and information handling the tortoise. In this race, the hare can win only if the tortoise does.

Classically, recorded information has been stored in private and public libraries. Classification systems have been devised for grouping items to facilitate their retrieval. To acquire information, individuals had to travel or write to libraries or else to colleagues or other sources of information, often with unsatisfactory results. Computers and other information storage and processing devices, apparatus for displays, and communications equipment now offer wide opportunities for access to remote information sources and for the production of comprehensive and personalized information "packages." Though ideas for this hardware are centuries old, machines capable of being used for complex, large-scale

information handling only began to appear within the last thirty years. Ideas for information handling applications have lagged behind the appearance of the hardware, and are far from well developed at the present time.

This paper examines several ideas for information handling that have been implemented that suggest directions for future development.



HANDLING LARGE DATA BANKS

Computer memories and micro images are alternatives to the printed page for the compact storage of large quantities of information. They pose challenges for information handling on scales beyond those practical to consider without them.

Though early computers were conceived for scientific problem solving, modifications were soon introduced for business and industry applications. The include such operations as inventory control, updating engineering specifications, coordinating requirements of customer orders, scheduling the use of machine tools, and cost accounting. The following examples illustrate some of the variety of uses, users, and equipment configurations that are state-of-the-art:

A. Customer service. To operate its 50,000-mile warranty program, the Chrysler Corp. installed an RCA 3301 - RACE system connected via commercial communication lines to video terminals in regional offices in 23 states. These provide on-line access to historic data on vehicles. Chrysler projects the need for 9 billion characters of on-line storage. Though the size of the file poses no problem for remote-inquiry access, updating is time consuming (20 hours for a 1.2 billion character file).[1a]

1a. "The Future of Electromechanical Mass Storage." Computers: Their Impact on Society, AFIPS Conference Proceedings. Vol. 27, pt. 2, 1965 Fall Joint Computer Conference. Washington, D.C.: Thompson Book Co., 1967, pages 77-83.

B. Marketing management. The food marketing system of Selling Areas-Marketing, Inc. (SAMI) keeps track of over 100,000 items for warehouse and chain operators in 20 major metropolitan areas. Input from over 175 food operators is converted from a variety of forms, including hand-summarized velocity reports, summary cards, disc and magnetic tape, to a common tape format. Over 130 programs were developed for reports to clients that are processed by a facility containing five 7070's, six 1401's, and a 360/50. Participants receive reports on their own four-week movements and comparisons of these with the rest of the measured market that enable item-by-item performance checks. Data elements include the item description (brand, size, flavor, etc.); deal description (cents off, etc.); case pack average shelf price; dollar sales; item share of total measured dollar sales of sub-category; food operators ordering during four weeks; and new items in market. Reports are available in hard copy, on tape, cards, and discs. SAMI plans to add teleprocessing facilities.[1b]

C. Production scheduling. Customer orders at Control Data Corp.'s Normandale Manufacturing Division are monitored through 11 210 display units (crt's with keyboards) linked to CDC 852 disc packs. At the end of each day, data are trans-

---

1b. Kenneth W. Silvers. "Computer Data Provides Basis for Food Marketing Program." Data Systems News, vol. 9, no. 10 (27 May 1968) 8,9.

ferred to magnetic tapes and are processed on a 3300. Updated tapes are recorded on the discs the following morning. The software is designed for data protection and simple terminal operation. Each production area can access only the information pertinent . its function. Some crt's are access-only stations (information cannot be entered). This system is part of a planned program for minimizing manual procedures in production control.[1c]

D. Scientific computing, much of it repetitious in nature. The Lawrence Radiation Laboratories facility included, in 1965, two 7094's, two 3600's, a LARC, a STRETCH, a 6600, 12 drums with the LARC, three Bryant disc files with the 6600, and a PDP-6 used exclusively for allocating work to the other units. To reduce the volume of output from a special 30,000 line/min. printer, LRL planned to increase its input/output terminals and give researchers more direct access to the computers.[1a]

E. Computer utility operation. A network of 160 terminals located throughout New England and connected to MIT's 7094 was the prototype of a utility designed for 24-hour operation. A hierarchy of types of memory of decreasing speed and increasing capacity was incorporated to enable simultaneous operation of the 30 terminals. To relieve users from involvement with equipment

---

1c. "Control Swings Into Production." Data Systems News, vol. 9, no. 15 (Oct. 1968) 8,10.

and file management problems, MIT undertook the development of operating and programming routines and the responsibility for terminal connections to operating equipment.[1a]

A variety of micro image forms have evolved for unit and continuous records. Film microforms include roll film, aperture cards (punched cards containing film chips), microfiche, microjackets (transparent jackets with pockets containing film strips or chips), and microstrips. Nonfilm forms include micro-opaques (produced by using film to imprint images on a card) and video tape. Systems include the following:

A. Customer inquiry service. Consolidated Edison Co. responds to about 5000 inquiries from customers in the New York City - Westchester County area daily. Gas, electric, and steam service records for 3 million customers are contained in microfilm magazines. Employees locate the film magazine and frame number via a video display until connected to a computer, and then access customers' accounts on a Recordak high-speed film reader.[2a]

B. Management control. Collins Radio Co.'s manufacturing schedules, inventories, and purchasing requirements are computer generated. The magnetic tape output is transferred by an SC 4020 to 16mm. microfilm and is distributed weekly in

2a. Edward J. Menkhaus. "The Many New Images of Microfilm." Business Automation (Oct. 1966) 32-43, 58.

cartridge form to 22 local and branch offices. Cost of operation is $2800; an earlier system producing 6 computer printout copies cost $3300.[2a]

C. Updating of customer records. The 400+ clerks in J.C. Penney's Catalog Division work with a microfiche directory containing the names, addresses, and account numbers of several million customers. The directory consists of 80 diazo duplicate "pages" of 16mm. film stripped onto 6 x 8 in. acetate sheets. The directory is issued biweekly. It replaced a 28,800 printed page version that had been updated every six weeks.[2a]

D. Retrieval of engineering drawings. Magnavox Co. designed a computer/microimage system (DARE, Documentation Automated Retrieval Equipment) for Redstone Arsenal's microfilm file of over 1.5 million engineering drawings. The system stores chips (3 in. pieces of 35mm. film) that are converted under computer control to aperture card form to satisfy requests.[2a]

E. Storage and retrieval of literature. The Technical Information System of North American Rockwell Corp.'s Aerospace and Systems Group maintains working files for about 1 million documents located in information centers in the Group's major divisions that serve about 114,000 professional employees. About 500,000 documents are under computer/microfiche system control. New accessions and company reports (about 30,000 annually) are

indexed and abstracted. The index terms and abstracts form the computer-based file from which a monthly catalog and index are generated. Microfiche masters are prepared by company-owned equipment; diazo duplicates are sent to the information centers. About 300 Bell and Howell Mascot portable microfiche readers and 25 Headliner readers are located in the information centers and engineering areas; portable readers are made available for office and home use. Throw-away duplicates at $.08 per copy are preferred over the $.80 cost per transaction to keep accounts on printed documents.[2b]

PROVIDING PERSONALIZED INFORMATION PACKAGES

The manipulability of data bases in computer-readable and micro image forms has resulted in the development of specialized information package subsets of larger files. In the realm of providing access to the scientific and technical literature, the following types of products have resulted:

A. Indexes. These include listings of subject terms and personal and corporate author names such as have been traditionally prepared by libraries, and new forms such as permuted title listings, lists of phrases excerpted from text based on frequency counts and other criteria, and custom-made shelf lists of varying degrees of specificity.

2b. Mark Keith & B.J. Funderburk. "Finding the Needle in the Haystack - and Putting it to Work for Progress." Data Systems News, vol. [illegible], no. 15 (Oct. 19[illegible]) 20,21.

B. Bibliographies. These also include lists of references similar to those heretofore prepared by libraries, and new forms containing annotations, keyword descriptors, relevance weightings, and abstracts of varying comprehensiveness determined by customer options.

C. Current awareness bulletins. Though lists of current accessions are not novel information packages, they are time consuming to compile manually, particularly when arranged by subject or other subset criteria. Such lists are almost by-products of machine-based systems.

D. Special interest current awareness bulletins. As generated by computers, these are novel products because of the substantially more complex processing that is possible. These products are obtained by comparing descriptors characterizing new accessions with those characterizing fields of interest of customers. Comparisons sometimes include numerical relevance weightings and other accept/reject criteria. Less complex to process and thus less expensive to the customer and more popular are lists in subject fields of interest to communities of users (e.g., computers; radiobiology).

E. Microimage packets. The low cost of microimage copies and the low costs of handling them enable dissemination of no-turn sets of unit records from collections on an as-requested or automatic basis.

F. Customized magnetic tapes and roll film. Copies of entire files and subsets are lately being made available at reasonable costs to customers having their own processing equipment. Customers include commercial information service firms that purchase the products of several originators, merge the files, and issue their own subsets based on their clients' needs.

PROVIDING INFORMATION SPECIALIST SERVICES

The rate of acceptance of new information processing equipment and new information products is far from uniform and has been generally greater among larger firms and members of already advanced information user groups. Several government programs were devised to help others gain an understanding of the new technologies and innovations. Two of these programs are those of NASA's Office of Technology Utilization (OTU) and the Department of Commerce's Office of State Technical Services (OSTS).

NASA established six regional dissemination centers (RDCs) whose mission was broadcasting the new knowledge being generated in NASA's research and development activities. The expectation was that these centers would know about the particular needs of their regions and would be able, through personal contact, to customize information products to match regional needs. Additionally, to exploit its own contributions to biomedical research, NASA formed several teams of specialists to identify promising areas

for biomedical research applications. NASA provides extensive information backup for these enterprises, including reports, bulletins containing abstracts of its own and related work, and specially commissioned publications and surveys on topics having commercial and non-aerospace potential. One of these publications, the <u>Tech Briefs</u> series, appears to have had the effect of altering the information acquisition and use habits of some scientists and engineers.[3] The performance of Indiana U.'s Aerospace Research Applications Center (ARAC) attests to the conceptual soundness of information center interfaces between information resources and users. Formed in 1963 as an RDC, ARAC is now independent (with some NASA sponsorship), and economically viable with some 70 regular member company clients and others who purchase services as needed.[4]

The OSTS program was directed to the State level. Under matching funds arrangements, the States were encouraged to assess their strengths and needs for new knowledge for academic and economic development purposes. Many novel approaches to information handling and dissemination have begun to emerge during the three years of this program.[5] Communication at a person-to-person

---

3. Theodore D. Browne, et al. <u>Project for the Analysis of Technology Transfer</u>. Quarterly evaluation rept. no. 3. Denver, Colo.: Denver Research Institute, Oct. 1968.

4. Joseph DiSalvo. <u>ARAC</u>, <u>Final Five Year Report</u>, <u>Experiment to Transfer Technology from a University-Based Center</u>. NASA Contract SC-NASr-162. Bloomington: Indiana U. Foundation, Feb. 1968.

level has, almost invariably, been at the foundation of successful undertakings. Whether these have resulted in the distribution of current awareness services or literature, the conduct of professional development seminars, the use of referral services, or the institution of educational television courses and radio broadcasts, all have been based on needs ascertained through personal inquiry. The value of a new type of professional, the information specialist, is beginning to be appreciated.

EXPANDING MAN-MACHINE INTERACTION

As noted above, many systems that handle large data bases provide for on-line remote terminal access. Well known are the airline ticket reservation systems. Less visible are systems used by banks, stockbrokers, insurance companies, railroads, and other services that have need for accurate current information for efficient operation.[6] Firms that sell computer time and programming services are indirectly contributing to much experimentation with the man-machine interface. Tymshare, Inc., for example, services clients whose applications include engineering design programming, machine tool control tape production (conversational APT), con-

---

5. For a summary of activities, see Office of State Technical Services, Annual Report, Fiscal Year 1968, Washington, D.C.: U.S. Dept. of Commerce, Jan. 1969. Available from U.S. Govt. Printing Office, $1.25.

Several projects are reviewed in more detail in Rowena W. Swanson. Information Entrepreneurship and Education ... Prescriptions for Technological Change. Arlington, Va.: Air Force Office of Scientific Research, March 1969. AFOSR 69-458TR.

tract estimating, classroom instruction of programming languages, electrical circuit design and analysis, and statistical analysis. Remote terminals include Teletype Models 33 and 35, ASR or KSR, Data Phones, TWX, and Tym_share's Mark V Data Transceiver plus voice-grade telephone lines.[7]

The man-machine potential is less advanced for data bases that are difficult to conceptualize in algorithmic form. For these, the machine provides displays of text and images. The user at audio-visual (e.g., educational TV) and microimage terminals must do most of his own information processing, but these media can make vast resources, sometimes otherwise unavailable, accessible to him. Research on computer-assisted instruction may be beginning to identify areas of application that will be economic and advantageous to exploit.[8] Several research groups are

---

6. A noteworthy example is the new Southern Pacific system. See "SP Shows $22 Million TOPS Information Network." Datamation, vol. 15, no. 1 (Jan. 1969) 87. TOPS will use two 360/65's, three 360/40's, four 360/20's, seven 2314 discs, 200 1050 data communications systems, 32 2260 crt display terminals, 200 teleprinters, and supporting equipment to monitor 2300 locomotives and 93,000 freight cars on SP's 14,000 miles of railroad track. The computers are being linked by a private microwave system. An elaborate training program was established for the 2500 people who will work with TOPS.

7. C.B.S. Grant. "Tymshare Moves Out With Computer School Graduates." Data Processing Magazine, vol. 10, no. 9 (Sep. 1968) 40, 41, 71.

8. Karl L. Zinn. "Instructional Uses of Interactive Computer Systems." Datamation, vol. 14, no. 9 (Sep. 1968) 22-27.

investigating the requirements for man-machine interaction for storing and retrieving information from the scientific and technical literature. MIT's Project Intrex, for example, is studying such questions as the possibility of interaction of networks of various systems (e.g., NASA, NLM); the value of terminals for browsing and on-line instruction; and tradeoffs between hardware and software for interface applications.[9]

The term, "man-machine interface," is usually applied only to machines under computer control. It may be profitable to enlarge this concept to include all of the new information processing machines, including displays and audio-visual equipment independent of computer control. Each has merits and limitations, and only combinations may be able to accomplish particular objectives with information that cannot be converted to computer processable form at the present time. Phenomena of import to information handling are beginning to be observed with the new machines. For example, TV is beginning to improve communications, and micro image files are reducing the need for volumes of printed materials. These phenomena result from changes in the information processing behavior of the man at the interface. They suggest that this interface offers rich potential for experimentation with information handling techniques.

---

9. Carl F.J. Overhage and R. Joyce Harman. INTREX, Report of a Planning Conference on Information Transfer Experiments. Cambridge, Mass.: MIT Press, 1965.

See also Project Intrex Semiannual Activity Reports. The current one is for the period Sept. 1968 - March 1969, Rept. No. PR-7, March 1969.

PLANNING INFORMATION HANDLING SYSTEMS

In contrast to other areas of practical applications of intellectual endeavor, information systems work does not rest on a body of theory and sage deliberation. It has no parent among the traditional academic disciplines, and it has many, simultaneously. Its theoretical foundations are becoming apparent from its practical successes and failures. It has a poor public image because it is blamed for every billing error, hardware fault, and inadequacy in management planning that manifest themselves to the user.

System designers have observed some phenomenological idiosyncracies that may, if overcome, reduce costs and apparent failures as well as improve images. These include:[10]

A. Lack of prior investigation by the customer of the need for a new system.

B. Absence of customer top management guidance or involvement other than verbal.

C. Inadequately conceived scope for the system, necessitating belated study of the customer's operations and, frequently, expensive and extensive revisions.

---

10. The items are drawn from Robert J. Mockler, "Developing a New Information and Control System." Michigan Business Review, vol. 20, no. 2 (Mar. 1968) 13-19.

D. Lack of knowledge on the part of the customer's decision makers of each other's information needs and operations, and reluctance to devote time to learning about them.

E. Poor interaction between the systems group and the customer's employees resulting in systems group failure to maintain a total information system perspective and objectivity in balancing the needs of each operational unit in the system.

F. Commitments by management to new systems before completing detailed studies of costs and hardware needs for performance requirements; both tend to be underestimated.

G. Management failure to anticipate changes in organizational structure and personnel dislocations occasioned by the new system.

The designer must work back from the user's needs and abilities to the system design. He must expect to make several design and test iterations before arriving at an acceptable price/performance ratio. Requirements of users in on-line systems pose added burdens, both because users must be given the flexibility for program modification based on feedback and because users often alter their specifications after they start to use a system. Use brings the desire, for example, for more file capability, different information structures, shorter response times, and new languages. A wider variety of equipment, language options,

and system design objectives and tradeoffs confront the designer of interactive systems.[11]

If there is a guiding principle in information system design, it seems to be: team work.

SUMMARY

Appropriate hardware and ideas on how information can be represented, manipulated, and offered to users must be blended together to produce effective information systems. Neither the best hardware nor the best ideas may exist today. They both, however, appear sufficiently advanced to pose no barriers to enterprising system designers and users in need of control over data bases. As systems develop and are modified, thought should be given to how they can be made interactive with other systems. Shortages of money, manpower, and time dictate the increasing necessity that their investment be exploited to the fullest.

---

11. The user's idiosyncracies and cautions in designing man-machine systems are discussed in Andrew Stephenson, "Planning Interactive Communication Systems." Modern Data Products, Systems, Services, vol. 1, no. 9 (Nov. 1968) 54-56.

POSTSCRIPT

This paper is intentionally brief to accommodate to space limitations of the proceedings for which it was prepared. In addition to the references cited in the text, the following are suggested for digging deeper.

1. Computer Yearbook and Directory, Second Edition. Frank H. Gille, ed. Detroit, Mich.: American Data Processing, Inc., 1968. $29.00.

This volume of 900+ pages contains over 25 state-of-the-art papers on software, hardware, and system applications. It also contains lists of professional associations involved in data processing; computer manufacturers; data processing services; and private and public data processing educational institutions.

2. Digital Industrial Handbook. Maynard, Mass.: Digital Equipment Corp., 1967.

This handbook is designed to educate the reader on computers and related equipment sufficiently to show advantages of digital techniques in industrial applications. Computer-based data acquisition and control systems, data logging systems, analog/digital subsystems, and the PDP series of computers are described. Available without charge from DEC.

3. Evaluation of Information Systems: A Selected Bibliography With Informative Abstracts. Madeline M. Henderson, comp. Washington, D.C.: National Bureau of Standards, Dec. 1967. NBS Technical Note 297. Available from U.S. Govt. Printing Office, $1.00.

This bibliography covers material published or available through June 1965. The references concern the evaluation of information retrieval systems and document reference systems, but not data processing systems per se. They are subdivided into four sections: comparative evaluations (33 refs.); descriptive evaluations (56 refs.); discussions of evaluation factors (31 refs); and proposals for techniques for evaluating system performance (34 refs.).

4. "Man's World of Facts. Special Report: Information Retrieval." Data Processor. vol. 10, no. 4 (Nov. 1967).

This issue of DP, an IBM journal, discusses the language and mechanical problems that must be faced for automated information retrieval. It also contains a section on applications of retrieval systems.

5. "Mastering the Man-Machine Interface," by George Flynn. Electronic Products, vol. 11, no. 9 (Jan. 1969) 20-30.

This paper reviews costs, tradeoffs, psychological factors, and hardware limitations involved in incorporating and using displays.

6. Methods of Information Handling. Charles P. Bourne. New York: John Wiley & Sons, Inc., 1963. $12.95.

The scope of this reference text is indicated from its chapter headings: the nature of the problem; classification and indexing: the organization of information; coding: the indexing shorthand; machine language representation; manual card systems; punched card systems; computer systems; other paper tape and magnetic media equipment; microfilm and image handling equipment. Representative applications are described throughout the text.

7. "Records Management Periodicals Bibliography." W. Arthur Allee, comp. Records Management Quarterly, vol. 3, no. 1 (Jan. 1969) 27-38.

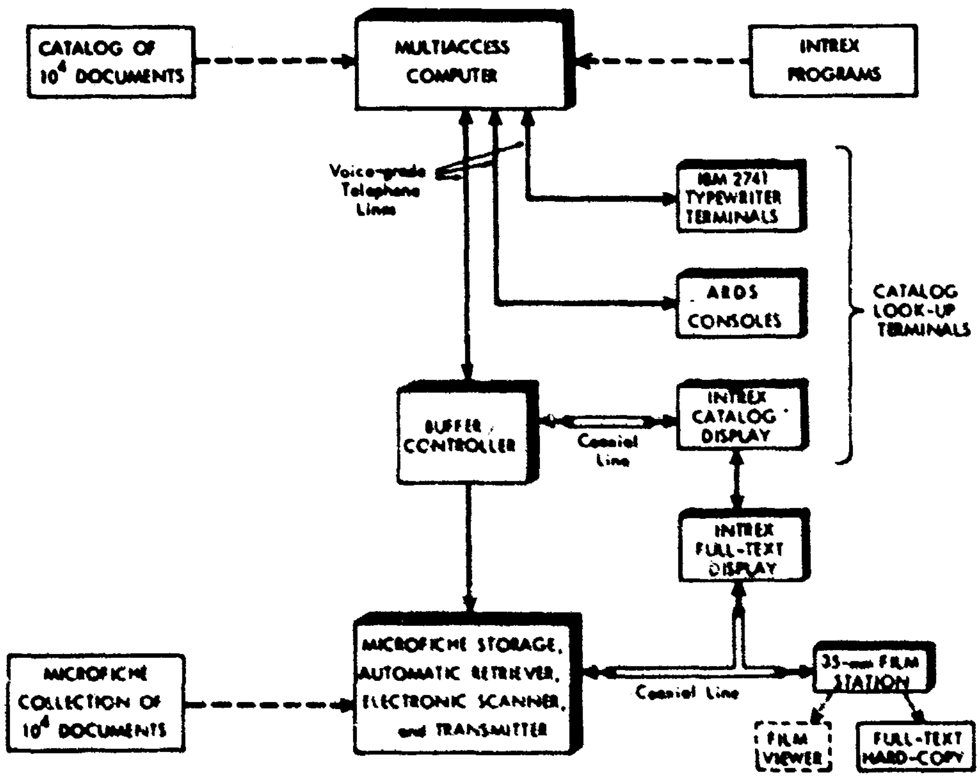
This bibliography is a feature of the journal. The cited supplement covers the period July 1967 - July 1968. The references are annotated and include citations to automation activities, microfilm applications, and education and training activities.

8. Status Report, National Standard Reference Data System, April 1968. Edward L. Brady, ed. Washington, D.C.: National Bureau of Standards, June 1968. NBS Technical Note 448. Available from U.S. Govt. Printing Office, 70¢.

The Office of Standard Reference Data is the hub of a network of data systems whose activities and publications are discussed in this report.

9. Study of Scientific and Technical Data Activities in the United States. Volume I - Plan for Study and Implementation of National Data System Concepts. Volume II, Parts A and B - Preliminary Census of Scientific and Technical Data Activities. Volume II, Part C - Preliminary Census of Scientific and Technical Data Activities. Final Report, ARPA Order No. 892, Contract F44620-67-C-0022, April 1968. AFOSR 68-1403, parts 1, 2, 3. AD-670,606, AD-670,607, AD-670,608, respectively.

Volume II of this Study is a reference source par excellence. Part A discusses the data activities in ten selected fields of science and technology, including characteristics of the data bases, data flows, data systems, and problems related to the field. Part B examines the data activities of several communities of users (medical research institutes, professional societies, commercial data processing centers, and U.S. Army RDT&E activities). Part C presents analyses of 266 data activities including data service centers, data-document depositories, and miscellaneous data acquisition programs.



Present Configuration of the Intrex System

[See Ref. 9, PR-7]

UNCLASSIFIED

Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author) Air Force Office of Scientific Research Directorate of Information Sciences Arlington, Virginia 22209	2a. REPORT SECURITY CLASSIFICATION Unclassified 2b. GROUP

3. REPORT TITLE
A LOOK AT TECHNOLOGIES VIS-A-VIS INFORMATION HANDLING TECHNIQUES

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)
Scientific interim

5. AUTHOR(S) (First name, middle initial, last name)

ROWENA W. SWANSON

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
May 1969	21	25

8a. CONTRACT OR GRANT NO. n/a	9a. ORIGINATOR'S REPORT NUMBER(S)
b. PROJECT NO. 9769	AFOSR 69-1205 TR
c. 6144501F	9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)
d. 681304	

10. DISTRIBUTION STATEMENT
1. This document has been approved for public release and sale; its distribution is unlimited.

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY
TECH OTHER	Air Force Office of Scientific Research Directorate of Information Sciences Arlington, Virginia 22209 SRI

13. ABSTRACT

The expression, "need to know," is, today, almost a euphemistic phrase for denoting the requirement for operating in our information-rich environments. Although luck, intuition, and hunches are likely to retain a place in many endeavors, the individual or organization having the right information at the right time in the right place has at least an initial advantage over those without this information. Thus, efforts to improve access to and control of information resources are paralleling the production of information. There is, however, a serious imbalance between these two activities. Production has been the hare and information handling the tortoise. In this race, the hare can win only if the tortoise does. This paper examines several ideas for information handling implemented with new technologies that suggest directions for future development. These are grouped under the topic headings: handling large data banks, providing personalized information packages, providing information specialist services, and expanding man-machine interaction. Guides in planning information handling systems are discussed. A brief bibliography of readings for digging deeper is appended. The author suggests that systems be designed and modified from the point of view of making them interactive with other systems where possible to most fully exploit the investment required in money, manpower, and time.

DD FORM 1 NOV 65 1473

UNCLASSIFIED

Security Classification